WASTE STREAM 5H306 JET Decommissioning Activated ILW

SITE Culham

SITE OWNER United Kingdom Atomic Energy Authority

WASTE CUSTODIAN United Kingdom Atomic Energy Authority

WASTE TYPE ILW

Is the waste subject to Scottish Policy: No

WASTE VOLUMES

		Reported
Stocks:	At 1.4.2022.....	0 m³
Future arisings -	1.4.2024 - 31.3.2027.....	157.0 m³
Total future arisings:		157.0 m³
Total waste volume:		157.0 m³

Comment on volumes: This waste is from decommissioning so the annual arisings will vary with the plans and progress. These have yet to be developed as the JET facilities are still operational. The planning assumption is that the decommissioning of JET starts in 2024. The waste quantities and activities are dependant on the JET experimental programme.

Uncertainty factors on volumes:

Stock (upper):	x	Arisings (upper)	x 2.0
Stock (lower):	x	Arisings (lower)	x 0.5

WASTE SOURCE The waste arises from decommissioning the JET facility.

PHYSICAL CHARACTERISTICS

General description: The waste will be largely redundant stainless steel plant and equipment, including carbon tiles. The items will range from small components to large sections of the vacuum vessel. Components will also be contaminated with beryllium (as well as tritium). There will also be some beryllium components. All large items will be size reduced in order to be accommodated within standard ILW containers.

Physical components (%vol): Physical constituents will be small and large items from the JET machine also equipment within the torus hall. Breakdown not available since JET experimental programme is on-going and inventory not finally established.

Sealed sources: Not yet determined.

Bulk density (t/m³): ~~1.7

Comment on density: The bulk density of 1.7 t/m³ is based on nominal 50% average voidage for plant items and an average density for components (range 1.8 - 8.4 t/m³).

CHEMICAL COMPOSITION

General description and components (%wt): Stainless steel (~74%), beryllium (<5%), copper (~5.5%), carbon steel (~8.2%), inconel (~5%), carbon/graphite (~2%), others (~0.3%).

Chemical state: Neutral

Chemical form of radionuclides: H-3: Mainly outgassed tritium present in the form of tritiated water vapour, and some absorbed into material surfaces.
C-14: As carbon in graphite/CFC tiles.

Metals and alloys (%wt): The metallic items are large scale fabrications from plate and bulk items. There is no information at present on proportions, but it is estimated that sheet metal will be less than 2% by weight.

	(%wt)	Type(s) / Grade(s) with proportions	% of total C14 activity
Stainless steel.....	~74.0		
Other ferrous metals.....	~7.2		
Iron.....	~1.0		
Aluminium.....	TR		
Beryllium.....	<5.0		
Cobalt.....	TR		

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Copper	~5.5	
Lead	TR	
Magnox/Magnesium	TR	
Nickel	~5.0	Inconel 600, Inconel 625.
Titanium	TR	
Uranium	TR	
Zinc	TR	
Zircaloy/Zirconium	TR	
Other metals	~0.30	Other metals (0.3%)

Organics (%wt): The extent of organic materials present is not estimated but are likely to be present in trace amounts. Epoxy resin is present in the divertor coils.

	(%wt)	Type(s) and comment	% of total C14 activity
Total cellulosics	TR		
Paper, cotton	TR		
Wood	TR		
Halogenated plastics	TR		
Total non-halogenated plastics	TR		
Condensation polymers	TR		
Others	TR		
Organic ion exchange materials	0		
Total rubber	TR		
Halogenated rubber	TR		
Non-halogenated rubber	TR		
Hydrocarbons	TR		
Oil or grease	TR		
Fuel	0		
Asphalt/Tarmac (cont.coal tar)	0		
Asphalt/Tarmac (no coal tar)	0		
Bitumen	0		
Others	0		
Other organics	TR		

Other materials (%wt): -

	(%wt)	Type(s) and comment	% of total C14 activity
Inorganic ion exchange materials	0		
Inorganic sludges and flocs	0		
Soil	0		
Brick/Stone/Rubble	0		
Cementitious material	0		
Sand	TR		
Glass/Ceramics	NE		
Graphite	~2.0		
Desiccants/Catalysts	0		

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Asbestos	0
Non/low friable	0
Moderately friable	0
Highly friable	0
Free aqueous liquids	0
Free non-aqueous liquids	0
Powder/Ash	0

Inorganic anions (%wt): No assessment of inorganic anion content has been made, but will be the subject of further work. However as this material is from the JET Torus, no salts are expected to be present.

	(%wt)	Type(s) and comment
Fluoride	0	
Chloride	0	
Iodide	0	
Cyanide	0	
Carbonate	0	
Nitrate	0	
Nitrite	0	
Phosphate	0	
Sulphate	0	
Sulphide	0	

Materials of interest for waste acceptance criteria: Beryllium.

	(%wt)	Type(s) and comment
Combustible metals	0	
Low flash point liquids	0	
Explosive materials	0	
Phosphorus	0	
Hydrides	0	
Biological etc. materials	0	
Biodegradable materials	0	
Putrescible wastes	0	
Non-putrescible wastes	0	
Corrosive materials	0	
Pyrophoric materials	0	
Generating toxic gases	0	
Reacting with water	0	
Higher activity particles	0	
Soluble solids as bulk chemical compounds	0	

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Hazardous substances / non hazardous pollutants: Beryllium is present on the internal surface of the vacuum vessel. All of this waste stream will be contaminated or potentially contaminated with beryllium.

	(%wt)	Type(s) and comment
Acrylamide	0	
Benzene	0	
Chlorinated solvents	0	
Formaldehyde	0	
Organometallics	0	
Phenol	0	
Styrene	0	
Tri-butyl phosphate	0	
Other organophosphates	0	
Vinyl chloride	0	
Arsenic	0	
Barium	0	
Boron	0	
Boron (in Boral)	0	
Boron (non-Boral)	0	
Cadmium	0	
Caesium	0	
Selenium	0	
Chromium	P	Included in specialist steels.
Molybdenum	P	Included in specialist steels.
Thallium	0	
Tin	P	Included in solder.
Vanadium	P	Included in specialist steels.
Mercury compounds	0	
Others	P	
Electronic Electrical Equipment (EEE)		
EEE Type 1	0	
EEE Type 2	0	
EEE Type 3	0	
EEE Type 4	0	
EEE Type 5	0	

Complexing agents (%wt): No

	(%wt)	Type(s) and comment
EDTA	0	
DPTA	0	
NTA	0	
Polycarboxylic acids	0	
Other organic complexants	0	It is unlikely that complexants will be present.
Total complexing agents	0	

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Potential for the waste to contain discrete items:	Yes.

PACKAGING AND CONDITIONING

Conditioning method:	To be determinated. Waste may be pre-treated to remove tritium.
Plant Name:	JET decommissioning waste packaging facility.
Location:	Culham
Plant startup date:	~2025
Total capacity (m³/y incoming waste):	NE
Target start date for packaging this stream:	-
Throughput for this stream (m³/y incoming waste):	NE
Other information:	Plant start date may change with date of termination of JET operations.

Likely container type:

Container	Waste packaged (%vol)	Waste loading (m³)	Payload (m³)	Number of packages
6m³ concrete box (HD)	100.0	~4.1	~5.0	39

Likely container type comment:	There is an opportunity to improve the packing factor and thus reduce the final number of packages. This will be explored in more detail once the initial packaging concept has been agreed in principle.
Range in container waste volume:	This will depend on the activity of the waste item(s).
Other information on containers:	-
Likely conditioning matrix:	Polymer
Other information:	Not finalised, but polymer encapsulation being persued as a preferred option, with the possibility of using inert glass beads as aggregate.
Conditioned density (t/m³):	~2.0
Conditioned density comment:	-
Other information on conditioning:	-
Opportunities for alternative disposal routing:	Not yet determined

Baseline Management Route	Opportunity Management Route	Stream volume (%)	Estimated Date that Opportunity will be realised	Opportunity Confidence	Comment
-	-	-	-	-	-

RADIOACTIVITY

Source:	Source of radioactivity is from activation by neutron irradiation of machine components and tritium contamination.
Uncertainty:	-
Definition of total alpha and total beta/gamma:	Where totals are shown on the table of radionuclide activities they are the sums of the listed alpha or beta/gamma emitting radionuclides plus 'other alpha' or 'other beta/gamma'.

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Measurement of radioactivities:	A method for calculating the total activity was given in the Alstec Decommissioning study, and is likely that FISPACT will have been used. The inventory is that estimated at 1 month after decommissioning decayed for 3 years as this is assumed to be the earliest time that completed packages will be prepared after cessation of operations, which equates to 2023 under the current operating schedule.
Other information:	Other beta/gamma includes Co-57 and Na-22. All components will be contaminated with tritium. If it were not for the anticipated levels of radioactivity from the tritium the material would be LLW.

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Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code	Nuclide	Mean radioactivity, TBq/m³ Waste at 1.4.2022	Bands and Code	Future arisings	Bands and Code
H 3			6.26E+01	A C 3	Gd 153				
Be 10					Ho 163				
C 14					Ho 166m				
Na 22					Tm 170				
Al 26					Tm 171				
Cl 36			6.97E-08	C C 2	Lu 174				
Ar 39					Lu 176				
Ar 42					Hf 178n				
K 40			2.44E-07	C C 2	Hf 182				
Ca 41			1.4E-08	C C 2	Pt 193				
Mn 53			2.16E-05	C C 2	Tl 204			1.82E-11	C C 2
Mn 54			2.17E-03	C C 2	Pb 205				
Fe 55			2.92E-02	C C 2	Pb 210				
Co 60			1.38E-02	C C 2	Bi 208				
Ni 59			1.32E-04	C C 2	Bi 210m				
Ni 63			4.12E-08	C C 2	Po 210			1.07E-10	C C 2
Zn 65			7.03E-07	C C 2	Ra 223				
Se 79					Ra 225				
Kr 81					Ra 226				
Kr 85					Ra 228				
Rb 87					Ac 227				
Sr 90					Th 227				
Zr 93			2.75E-11	C C 2	Th 228				
Nb 91			1.72E-08	C C 2	Th 229				
Nb 92			7.8E-08	C C 2	Th 230				
Nb 93m			4.13E-06	C C 2	Th 232				
Nb 94			3.99E-08	C C 2	Th 234				
Mo 93			3.2E-08	C C 2	Pa 231				
Tc 97					Pa 233				
Tc 99			2.28E-10	C C 2	U 232				
Ru 106					U 233				
Pd 107					U 234				
Ag 108m			1.59E-06	C C 2	U 235				
Ag 110m			4.59E-04	C C 2	U 236				
Cd 109			2.46E-09	C C 2	U 238				
Cd 113m			6.44E-10	C C 2	Np 237				
Sn 119m			1.04E-06	C C 2	Pu 236				
Sn 121m			4.05E-08	C C 2	Pu 238				
Sn 123			9.16E-09	C C 2	Pu 239				
Sn 126					Pu 240				
Sb 125			1.49E-06	C C 2	Pu 241				
Sb 126					Pu 242				
Te 125m					Am 241				
Te 127m					Am 242m				
I 129					Am 243				
Cs 134			1.3E-07	C C 2	Cm 242				
Cs 135					Cm 243				
Cs 137					Cm 244				
Ba 133			2.69E-05	C C 2	Cm 245				
La 137					Cm 246				
La 138					Cm 248				
Ce 144					Cf 249				
Pm 145					Cf 250				
Pm 147					Cf 251				
Sm 147					Cf 252				
Sm 151					Other a				
Eu 152					Other b/g			1.68E-02	C C 2
Eu 154					**Total a**	**0**		**1.07E-10**	**C C 2**
Eu 155					**Total b/g**	**0**		**6.27E+01**	**C C 2**

Bands (Upper and Lower)

A a factor of 1.5
B a factor of 3
C a factor of 10
D a factor of 100
E a factor of 1000

Note: Bands quantify uncertainty in mean radioactivity.

Code

1 Measured activity
2 Derived activity (best estimate)
3 Derived activity (upper limit)
4 Not present
5 Present but not significant
6 Likely to be present but not assessed
7 Present in significant quantities but not determined
8 Not expected to be present in significant quantity